

2

BRAIN STUDIES AND MATERIALS FOR LANGUAGE LEARNING

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Introduction

There seems to be marked growth in global interest and awareness of how the brain holds the key to understanding human behaviour, be it physical or mental. In this chapter, I would like to explore implications of brain studies to theories and practice in second language acquisition and materials development for language learning.

When a child alerts a mother, 'My tummy hurts', the problem is likely to lie somewhere, academically put, in the architecture and the processes that constitute the phenomena of 'digestion'. Medical advancement now enables the specialists to directly observe, analyse and measure:

- how the ingested food is processed;
- what kinds of organs or anatomical structures are involved;
- what kinds of chemicals need to be secreted.

If the mother were to seek detailed explanations, she would be able to find out about 'the digestive system and processes' from an anatomical level (e.g. stomach) and a cellular level (e.g. G-cell) to a molecular level (e.g. constitution of enzymes). Most mothers would sensibly leave such academic endeavours to specialists and request advice for appropriate solutions to their child's specific 'tummy ache' problem.

What is important, however, is that, if required, such information is abundantly available in accessible ways. It would be ludicrous for any lay people to completely disregard a basic understanding of digestive systems that are vital for sustaining our lives. Fundamental knowledge about our body and ways of maintaining health is widely made available as part of school subjects, on public health websites and in many other resources in the media.

When a second language (L2) learner alerts a teacher, 'I don't want to learn English', would a teacher be able to resort to her understanding of brain studies to

support her own observation, experience and learning of second language acquisition? What is 'motivation'? Are we able to directly observe, analyse and measure 'motivation' as we can in the case of 'digestion'?

Traditionally such constructs were assumed to be not amenable to direct physical examination. 'Motivation' is a psychological/mental phenomenon that is complex, dynamic and invisible (for various definitions, see Dörnyei and Ushioda, 2011). Researchers in social, humanistic and psychological sciences refer to such unobservable and complex concepts as 'psychological/mental constructs'.

Researchers in psychology, education and applied linguistics have been studying such 'unobservable' psychological/mental constructs through systematic empirical research using indirect probes and quantitative, qualitative or mixed methods (methodological discussions are available in Cohen et al., 2011; Dörnyei and Ushioda, 2011; Mackey and Gass, 2005; Nunan and Bailey, 2009).

Though we gain a lot of insights through such empirical studies in these fields, consensus among researchers remains elusive mainly due to the fact that research requires feasible segmented focus with different methods and interpretation. Based on their survey of the studies on motivation, for example, Dörnyei and Ushioda (2011, p.4) describe the current status by using an analogy of an 'Indian fable of the blind men encountering an elephant, each touching a different part of the animal (tusk, tail, ear, trunk, belly) and ending up with a very different mental representation of the animal'.

What is urgent is that, regardless of current situations of theories about second language acquisition, a teacher who is facing a low-motivated learner is expected to find a way somehow of helping him/her to acquire an additional language. Materials developers have been expected to provide a sound tool for teachers to conduct the task of facilitating Second Language Acquisition.

The good news is that recently there have been remarkable developments in brain studies, supported by various funds, that could change the current picture surrounding learning, teaching and materials development:

Technological Advancement in the Study of the Brain

We are seeing a concerted effort to accelerate the development and application of new technologies that will enable researchers to produce dynamic pictures of the brain that show how individual brain cells and complex neural circuits interact at the speed of thought as can be seen in the Brain Initiative (2013–2025): <http://www.kavlifoundation.org/brain-initiative>.

These technologies could open new doors to explore how the brain records, processes, uses, stores and retrieves vast quantities of information, and shed light on the complex links between brain function and behaviour. Psychological/mental constructs could become more observable, analysable and measurable. In other words we might be able to eventually explain what constitutes 'motivation' as we do in 'digestion'.

Collaborative and Interdisciplinary Efforts in the Investigation of Learning

Language acquisition is a complex phenomenon that requires interdisciplinary accounts. Fischer et al. (2010, p.68) acknowledge a growing demand worldwide for interdisciplinary efforts to combine neurobiological studies with cognitive science and with social and humanistic disciplines. They describe the emergence of Educational Neuroscience as a new field in the USA that brings together biology, cognitive science, developmental science and education to investigate brain and genetic bases of learning and teaching.

Fischer et al. (2010) refer to the cases in which research and practice combine routinely in many industries and fields to create usable knowledge that has great practical value. They advocate collaboration between researchers, teachers and learners so that more useful research evidence can be fed back productively to shape schools and other learning situations.

Fischer et al. (2010) also argue for improvements in the current one-way practice in which researchers collect data in schools and make those data and the resulting research papers available to educators. Instead they recommend a two-way dialogue in which 'practitioners and researchers work together to formulate research questions and methods so that they can be connected to practice and policy' (Fischer et al., 2010, p.68).

There must be billions of teachers globally who work with unmotivated learners and who blame themselves or their teaching context. It seems to me to make sense that such a global issue be tackled with interdisciplinary collaboration without artificial boundaries of science, occupations and specialities.

Basic Brain Knowledge for All

Neuroscience seems to be gradually becoming a part of learning in schools and in teacher development. For example, BrainFacts.org offers an authoritative source of information about the brain and nervous system for the public and educators. The organization provides Neuroscience Core Concepts for educators that are correlated to the US National Science Education Standards. The Allen Institute for Brain Science (<https://www.alleninstitute.org/our-research/open-science-resources/>) offers free and open resources to anyone around the world.

Obviously, we should be wary of neuro-myths that seem to be in abundance in the market. We should be realistic in our expectations of what neuroscience can tell us when there still is enormous scientific uncertainty. The scanned images or computer-simulated images may be dazzling but the research results should be presented and interpreted appropriately within the context, and findings should not be used to answer questions they were never designed to answer. Interdisciplinary studies bring in new definitions and interpretations of the same phenomenon examined in different ways.

In sum, just as dealing with ‘tummy ache’ should be based on the studies on ‘digestion’, our discussion of ‘language acquisition’ or ‘developing materials for language learning’ would benefit from consideration of the nature of the human brain and its mechanisms of language processing, learning and memory. In this sense, I agree with Jacobs and Schumann (1992) when they argue that:

Language acquisition researchers must begin to incorporate a degree of neurobiological reality into their perception of the language acquisition process. Research that extrapolates mental metaphors from observed behavior must be supplemented and constrained by a neutrally inspired paradigm that attempts to understand behavior based on the structure of the organ from which all behavior originates: the brain . . . A neutrally inspired perspective extends to almost all areas of inquiry into the human condition and provides a common ground for integrating various perspectives of the language acquisition process.
(p. 295)

N. Ellis (2002, p. 299) notes, ‘We are now at a stage at which there are important connections between SLA theory and the neuroscience of learning and memory.’

Dörnyei (2007) also emphasizes the critical importance of a shift in the SLA paradigm:

I had to realize that applied linguists simply do not have the option of ignoring the new psychological approaches because the advances in these areas are leading to a fundamental restructuring of our knowledge base of language acquisition and language processing. Disregarding these developments would lead to the marginalization of the field of applied linguistics/second language research.

(pp.xi–xii)

What are lacking at the moment seems to me to be projects that explore the validity and applicability of findings from brain studies in relation to language acquisition and materials development. Such investigation must have wider interdisciplinary perspectives, combining the scientific findings with what we know from our direct experience about what happens in the language learning classroom.

As part of such projects, in this chapter I’ll focus on affect and mechanisms of the brain that seem to have attracted fairly wide consensus among neuroscientists and that could bring significant improvements to theories and practice of SLA and materials development.

The Construct and Role of Affect in Learning

Arnold and Brown (1999, p.1), after evaluating various definitions, provide a broad definition of ‘affect’ as ‘aspects of emotion, feeling, mood or attitude which condition behaviour’.

Affect is one of the teachers' major concerns around the world as they face the challenges every day of having to persuade unmotivated students to engage with second/additional or foreign language learning. They are fully aware of the vital importance of learners' motivation, emotion, moods, attitudes and aspirations. Where can a teacher find information and guidance?

Matthewson (1994) draws our attention to a stark contrast in relation to the coverage of affect between pedagogic and research publications since the 1950s. Affect-related topics maintain popularity over the years in the pedagogic publications such as *The Reading Teacher* (Dillon et al., 1992). Publication on reading research, on the other hand, included hardly anything on affect-related topics. This could be due to the behaviouristic tradition in psychology and psycholinguistics, which tended to sideline affect as an elusive and peripheral phenomenon unworthy of serious investigation. All the major models of reading in the 1970s, for example, were heavily influenced by information processing studies (e.g. artificial intelligence, connectionist studies). This meant that human emotion, interest or motivation did not feature in reading research at all. The direct consequence was teaching materials for reading that focused solely on linguistic processing without much, if any, concern for learners' interest or motivation.

Brain studies seem to provide undeniable anatomical and physiological evidence that the affect plays a vital and fundamental role in human biological and social survival (Damasio, 1994; Damasio & Carvalho, 2013; Gazzaniga et al., 2014; Immordino-Yang & Damasio, 2007; Phelps & LeDoux, 2005). With the help of the advancement of clinical and experimental studies supported by neuroimaging, neuroscientists are able to show how memory (i.e. learning) can be enhanced or diminished by affective colouring and how such structural mechanisms have developed in the evolution of the species.

Damasio and Carvalho (2013, p. 143), for example, define 'feeling' as 'mental experiences of body states'. They explain that the 'felt experience' may signify not only 'physiological need such as hunger, pain, fear, anger and well-being' but also more socially inspired reactions such as 'compassion, gratitude or love'. Ortega (2009) explains that 'Motivation is usually understood to refer to the desire to initiate L2 learning and the efforts employed to sustain it.' The dynamic, individual and complex nature of 'motivation' (Dörnyei & Ushioda, 2011) seems to fit well with a visceral biological and cognitive account based on in-built desire for better biological and social survival (Lee et al., 2009). Imagine an EFL learner who associates reading with painful translation routines. Consciously she may tell herself that she needs to learn to read fluently in L2 as her extrinsic motivation is to pass the exams in order to gain entry to an esteemed university. Right after reading she knows that she will be tested on her comprehension and on the language contained in the text. What will be her internal state and her feeling? What kinds of research data would a researcher get if this girl was a respondent in the questionnaire and interview studies on motivation in relation to classroom language learning? Would she be able to articulate why she reads in the way she does during reading lessons? The same learner, however, might read with far superior comprehension if she

were to receive a love letter in English from the boy of her dreams. What would be her internal states and her feeling then? If there were unfamiliar words, would she be able to work out their meaning and moreover learn them?

Damasio and Carvalho (2013) argue that 'Feeling paved the way for the establishment of higher levels of cognition and consciousness, culminating in the modern human mind.' In fact, the title of the article by Immordino-Yang and Damasio (2007) 'We feel therefore we learn: The relevance of affective and social neuroscience to education' sums up their view of how sentience (i.e. the ability to feel, perceive or experience subjectively in contrast to reasoning) controls learning, attention, memory, decision making and social functioning. Bolte Taylor (2009, p.19), a neuroscientist, confirms such a claim based on her own experience of recovering from a stroke, by saying that 'Although many of us may think of ourselves as thinking creatures that feel, biologically we are feeling creatures that think.'

Implications of Placing Affect at the Heart of Research and Materials Development

What does SLA research tell teachers about affect? Has the situation changed since Matthewson (1994) reported a paucity of research on affect in reading research?

A quick survey of recent handbooks of research on Second Language Acquisition reveal that affect is not being considered as a core aspect of learning. For example, Gass and Mackey (2012) and R. Ellis (2008) do each include a chapter, respectively on 'Neurocognition of second language' and 'The neuropsychology of second language acquisition', but the main discussions seem to focus on cortical language processing, and their indexes do not include 'affect' or 'emotion'. Ortega (2009) does have chapters on 'Motivation' and 'Affect and other individual differences', but both chapters seem to be an overview of existing empirical research that considers 'motivation' as one of the variables of 'individual differences'. Task-Based Language Teaching has attracted a lot of attention from SLA researchers (e.g. Van den Branden et al., 2009). The researchers' concerns, however, seem to centre around increases in linguistic processing capacities. The indexes include 'goals' but not 'affect' or 'emotion'.

Having affect in the central position would influence how we might design research. I would like to introduce three examples below:

Example 1: Brain studies would predict that learners' affect towards the text and towards the task should be two of the major variables for Task-Based Teaching research. How engaging the text and the task are for the learners would be seen to influence their achievement. Tomlinson (2013) argues the vital importance of engaging texts and tasks to drive materials. Research that incorporates his Text-Driven Approach has demonstrated engagement and a positive and lasting effect on language acquisition (Rico Troncoso, 2010).

Example 2: Kuperman et al. (2014, p.1065) maintain that emotion influences most aspects of cognition and behaviour and yet that 'emotional factors

are conspicuously absent from current models of word recognition'. Their results demonstrate a difference in word recognition rate between positive and negative words. They claim that incorporating emotional factors, especially valence, improves the performance of models of word recognition.

Example 3: Widening the context, Lee et al. (2009) attempt to offer a perspective on language acquisition based on evolutionary biology and neurobiology. Schumann (2013), for example, attempts to unify first language acquisition and second language acquisition and explore neurobiological explanations as to why a successful L1 learner may not necessarily succeed in learning an additional language.

What would be the implications of these brain studies for materials development?

Criterion-referenced surveys of global coursebooks for adult learners (e.g. Tomlinson and Masuhara, 2013) provide evidence that most coursebooks follow PPP (Presentation – Practice – Production) procedures. The problem is that PPP may be a convenient teaching procedure but it ignores what we know about when, why and how the brain learns. Listening to a presentation on an isolated and decontextualized language feature can help rational focus but is unlikely to stimulate affective engagement, especially if that feature has been selected because it comes next in the syllabus or coursebook rather than because it is conspicuously relevant to the lives, needs and wants of the learners. Likewise controlled practice of the feature without a situational purpose and guided production of the item in a prescribed and pseudo-communicative situation are unlikely to achieve the affective stimulation needed for effective and durable acquisition. Of course, if the learners have already encountered the language feature in an engaging text and/or task, have found it problematic and/or interesting and have asked the teacher for information, then the PPP procedure might have more value, providing that the presentation, practice and production relate to the text and/or task and to what the learners found problematic and/or interesting.

Based on my understanding of how affect drives learning and memory, I would strongly argue that teaching approaches should aim to ultimately provide opportunities for the self-fulfilment of learners. The brain is designed to enhance life by learning. In this sense, relevance, meaningfulness and the value of materials to the individual would play crucial roles. The activities should be engaging and contribute to well-being, so much so that the learners would want more (Fredrickson & Branigan, 2005). The bias towards reasoning skills and factual knowledge in the learning environment needs to be rebalanced with the notion of sentience (i.e., as stated above, the ability to feel, perceive, or experience subjectively in contrast to reasoning) in the mind. The implications here are that the potential for affective engagement should be the prime criterion when writing or selecting texts and tasks and that learner choice of texts and tasks should be a vital consideration when designing materials. Ways of achieving this would include helping learners to select or find a text that they want to use with the tasks specified in their materials or selecting from a menu of tasks those they want to use in response to a potentially engaging text.

The opposing voices may say that ‘We are language teachers. Our job is to teach the language; “self-fulfilment” and affect are beyond our duties.’ Immordino-Yang and Damasio (2007, p.9) warn that ‘neither learning nor recall happen in a purely rational domain, divorced from emotion, even though some of our knowledge will eventually distil into a moderately rational, unemotional form’. They also point out that unmemorable knowledge inherently does not transfer well to the real-world situation. They say, ‘As recent advances in the neurobiology of emotions reveal, in the real world, cognition functions in the service of life-regulating goals, implemented by emotional machinery’ (see also Rice et al., 2007; Van Kleeef et al., 2014). Do we want to ignore affect and fail in our job to teach the language? What is even worse, perhaps we may be the ones that are producing bored students with an aversion to learning, doomed to fail in society? Neurobiological insights can help us become better teachers, researchers and materials developers.

Conclusion

What I am claiming is that scientific study of the brain in action during the learning process has confirmed the significance of factors which have been drawn attention to in the literature but which are often considered as peripheral by SLA researchers. In this chapter I have focused on affect, but brain studies have also revealed the positive effect on language acquisition of such factors as macro- and multi-dimensional processing of language input, creativity, positive energy and experiential learning. In other words, brain studies have demonstrated how important it is that learners are given an engaging and holistic experience of acquiring their target language and are not just restricted to the discrete learning and practice of language items. This message needs to be passed on in accessible and persuasive ways to language teachers so that they can adapt and supplement their coursebook materials with activities which their learners really want to do and which motivate them through enjoyment, fun, laughter and achievable challenge.

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Brain Studies Related Websites:

Allen Institute Open Resources: <https://www.alleninstitute.org/our-research/open-science-resources/>

The Allen Institute provides open and free resources. See also <http://www.brain-map.org/> in which tutorials are provided, giving orientation videos of how their resources can be explored.

BrainFacts.org: <http://www.brainfacts.org/educators/educator-resources/>

An authoritative source of information about the brain and nervous system for the public.

The Brain Initiative (2013–2025): <http://www.kavlifoundation.org/brain-initiative>
 ‘A broad, collaborative research initiative to advance the science and technologies needed to unlock the mysteries of the human brain. Its goal: Accelerate the development and application of new technologies that will enable researchers to produce dynamic pictures of the brain that show how individual brain cells and complex neural circuits interact at the speed of thought. These technologies will open new doors to explore how the brain records, processes, uses, stores, and retrieves vast quantities of information, and shed light on the complex links between brain function and behavior.’

The Dana Foundation: <https://www.dana.org/About/>

A private philanthropic organization that supports brain research through grants, publications, and educational programs. It is committed to advancing brain research and to educating the public in a responsible manner about the potential of research.

National Institute of Health <http://www.nih.gov/>

National Institute of Neurological Disorders and Stroke: <http://www.ninds.nih.gov/education/>

On this site, you’ll find great educational resources related to brain health and function for parents, students, and teachers.

Society for Neuroscience: <http://www.sfn.org/about/what-we-do>

‘The Society for Neuroscience is the world’s largest organization of scientists and physicians devoted to understanding the brain and nervous system. The nonprofit organization, founded in 1969, now has nearly 40,000 members in more than 90 countries and 130 chapters worldwide.’

Brain researcher Jill Bolte Taylor studied her own stroke as it happened – and has become a powerful voice for brain recovery: http://www.ted.com/talks/jill_bolte_taylor_s_powerful_stroke_of_insight